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# CONCURRENT RESEARCH ON HIGH GRAVITY (G) COMBUSTION AND ENABLING MATERIALS

(LRIR: 99PR12ENT)

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## SUMMARY/OVERVIEW:

This is a joint program between MLLN and PRTS. Fundamental combustion and materials science issues are being investigated that will lead to the development of a revolutionary propulsion system that operates on a highly efficient near-constant temperature (CT) cycle instead of the constant pressure cycle of today's engines. A key technology essential for the development of a propulsion system that operates on a CT cycle is an ultra-compact inter-turbine burner (ITB) that will efficiently add heat between the turbine stages and is constructed of advanced, lightweight ceramic-matrix composites (CMC) materials.

## TECHNICAL DISCUSSION

Experiments have been conducted in an instrumented, small-scale, axi-symmetric, atmospheric pressure laboratory combustor with an outer circumferential cavity in which the flame is stabilized by a highly accelerated swirled flow. The swirl is generated by air jets around the outer wall of the cavity. Estimated g-loading in this cavity is ~1000g. Fuel is introduced into the cavity by pressure atomizing nozzles. Unswirled air flows down the center of the combustor with approximately 4x the mass flow rate of that introduced into the cavity. Observed flame lengths in this combustor are significantly shorter than those observed in a conventional swirl stabilized gas turbine combustor at similar equivalence ratios. These shorter flame lengths were achieved with no penalty to combustion efficiency; combustion efficiencies of +99% for both ethanol and JP-8 fuels were observed over a wide range of operating conditions and Longwell Parameters down to $O(10^7)$. High efficiencies have been observed for cavity equivalence ratios up to $\phi_{cav} > 2$ and overall equivalence ratio of $\phi_{cav} \approx 0.6$. Lean blowout occurs as low as $\phi_{cav} = 0.5$ in the cavity. These combustion results have been recently reported by R. A. Anthenien et al. in a paper entitled "Experimental Results for a Novel, High Swirl, Ultra Compact Combustor for Gas Turbine Engines" at the 2nd Joint Meeting of the U. S. Sections of the Combustion Institute, Oakland CA, 25-28 March 2001. Background information on this program will be presented in the Tuesday afternoon section on combustion and materials.